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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

INSTRUMENT ASSEMBLER (any ind.) 7-09.610

B-530 S-253

U. S. Employment Service in
Cooperation with
California State Employment Service

May 1963

GATB # 2426

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

INSTRUMENT ASSEMBLER (any ind.) 7-09.610

B-530 S-253

Summary

The General Aptitude Test Battery, B-1002A, was administered to a final sample of 50 Instrument Assemblers 7-09.610 employed by Guidance Technology Incorporated, Santa Monica, California. The criterion consisted of supervisory ratings. On the basis of mean scores, standard deviations, correlations with the criterion, job analysis data, and their combined selective efficiency, Aptitudes S-Spatial Aptitude, F-Finger Dexterity, and M-Manual Dexterity were selected for inclusion in the final test norms.

GATB Norms for Instrument Assembler 7-09.610, B-530 S-253

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
S	CB-1-F CB-1-H	85	S	Part 3	80
F	CB-1-O CB-1-P	100	F	Part 11 Part 12	95
M	CB-1-M CB-1-N	90	M	Part 9 Part 10	85

Effectiveness of Norms

The data in Table IV indicate that only 64 percent of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 83 percent would have been good workers. 36 percent of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 17 percent would have been poor workers.

TECHNICAL REPORT

I. Purpose

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for the occupation of Instrument Assembler 7-09.610.

II. Sample

During the period March 12 through May 11, 1962, the GATB, B-1002A, was administered to a sample of 17 male and 26 female Instrument Assemblers. Nine females who were tested in 1959 were included in the sample without retesting. Two workers were eliminated from the sample: one male because of hand injuries which invalidated parts 9 through 12 of the GATB and one female because of not having completed the training period. Therefore, the final sample consisted of 16 male and 34 female Instrument Assemblers 7-09.610 employed by Guidance Technology, Inc., Santa Monica, California.

The company utilizes all available sources of recruitment to hire trainees for work classified as electro-mechanical assemblers. There are no fixed age or educational requirements. The ability to speak, read, and write English is required. Trainees with some factory or other work experience which required considerable use of hands and fingers are preferred. The company has not utilized tests in the hiring process. There are no formal training programs. On-the-job training under close supervision is utilized. There is no specified training time or established rate of progress. All of the workers in the final sample are considered experienced workers.

TABLE I

Means (M), Standard Deviations (σ), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education, and Experience

N = 50	M	σ	Range	r
Age (years)	35.4	10.3	19-58	-.141
Education (years)	10.9	1.9	6-14	-.038
Experience (months)	35.9	31.7	4-130	-.063

III. Job Description

Job Title: Instrument Assembler (any ind.) 7-09.610.

Job Summary: Performs various job duties in assembling gyroscopes: assembles parts and units such as stators, rotors, gimbals, slip rings, wipers, and frames; wires and solders connections in accordance with coded, wiring diagrams; adjusts gimbal pivotal end plays; and visually inspects work. Uses various instruments and tools including arbor press, tension and dial gages, micrometer, electric soldering iron, wire cutter and stripper, Allen and Spanner wrenches, jeweler's screwdriver, tweezers, and hypodermic syringes.

Work Performed: Performs final assembly of stator: Positions pre-wired and subassembled stator in bench holding fixture. Screws balance screw into stator shaft with Allen wrench. Visually inspects work and places stator in cellophane bag.

Assembles stator into rotor: Selects two matched rotor shell halves from supply. Removes stator from cellophane bag, holds stator in one hand and picks up rotor shell half with free hand. Inserts motor wire lead shaft of stator through shell journal. Picks up insert shell half and fits shell journal over balance screw shaft of stator. Presses shell halves together and rotates halves until witness marks are in alignment. Positions assembly on bed of arbor press, rechecks alignment of witness marks and pulls down on press lever to actuate ram and press rotor shell halves together to tight fit.

Assembles inner gimbal: Unscrews gimbal cap, sets screws with jeweler's screwdriver and removes cap from gimbal. Inserts shanks of terminal posts into terminal holes of housing and presses posts to snug fit with fingers. Slip fits outer and inner race bearings over pivot shafts and into housing bore. Inserts rotor sssembly into gimbal housing and guides motor lead wires through bore with fingers. Fits outer race bearing into gimbal cap bore and slides cap down over inner race bearing pre-assembled on rotor balance screw shaft. Replaces cap on gimbal housing and secures cap with setscrews. Slides shims, bearing retainers and lock washers down over rotor shafts and secures parts finger tight. Inserts gimbal into caging ring, aligns ring holes with pre-machined holes in gimbal housing, and secures rings to gimbal with washers and setscrews. Visually inspects completed work.

Assembles and wires inner gimbal: Withdraws slip ring from protective glass tube with tweezers and twists wire leads together with fingers. Threads wires down hollow center of gimbal pivot and out through slot at pivot base. Pulls wires to draw slip ring down to pivot and applies cement around junction of ring and pivot with wire applicator. Presses ring down with fingers to firm seat and ascertains that cement has made good bond. Cuts coded motor and slip ring wires to specified lengths, strips ends, and solders wire ends to terminals in accordance with wiring diagram. Deposits drop of glyptol with hypodermic syringe on setscrews to form vibration-tight seal. Places masking tape covering over slip ring to prevent subsequent damage and visually inspects work.

Assembles outer gimbal: Assembles tension bar sleeve and inserts sleeve into pivot of outer gimbal shell. Secures sleeve with snap retaining ring, adjusts spring tension of sleeve with screwdriver, and checks amount of tension with a tension gage. Slides alignment sleeve up over lead wires of pre-assembled slip ring. Threads lead wires through gimbal slip ring pivot. Pulls alignment sleeve down and presses sleeve shank into pivot with fingers. Applies thin coat of cement to sleeve and pivot junction. Pulls on lead wires and guides slip ring shank into alignment sleeve. Fits terminal posts into pre-machined holes in gimbal shell. Draws plastic tubing over lead wires and pushes tubing to base of slip ring pivot. Fits clamping bracket over wires encased in tubing and fastens bracket to gimbal with washers and setscrews. Prepares lead wires for soldering and solders wire ends to specified terminals. Removes slip ring bearing retainer screws, positions shim and wiper molding over exposed holes, and secures molding with washers and setscrews. Aligns wiper wires in slip ring grooves and adjusts tension of wires with tweezers. Prepares and solders wiper lead wires to specified terminals on gimbal. Visually inspects work.

Assembles inner gimbal into outer gimbal: Selects matched inner and outer gimbal pair. Removes setscrews holding pivot onto inner gimbal and disengages pivot. Inserts inner gimbal into outer gimbal, centering slip ring pivot into outer gimbal bearing bore. Reassembles pivot to inner gimbal and places drop of glyptol on each setscrew. Positions bearings and shims on inner gimbal pivots and centers inner gimbal in outer gimbal. Positions bearing retainers over bearings and tightens retainers with screwdriver. Spins inner gimbal with fingers to ascertain resistance free rotation.

Checks end play between inner gimbal pivots and outer gimbal: Removes one setscrew from bearing retainer and screws dial gage post holder into exposed hole with fingers. Slides dial gage down on post holder with gage lever knob resting on end of inner gimbal slip ring. Tightens gage to holder and sets gage reading to zero. Holds gimbal assembly in one hand with pivots in vertical plane. Rotates assembly clockwise 180 degrees to seat bearings. Returns assembly to original position and resets gage. Repeats clockwise rotation causing free fall between inner and outer gimbal bearing shoulders to depress knob of dial gage lever and actuate gage indicator. Reads gage and ascertains that amount of end play (free fall) is within specified tolerance. Removes gage and holder when end play requires adjustment. Disassembles bearing retainer plate and removes shim. Selects another shim and checks thickness of shim with micrometer. Reassembles new shim and bearing retainer plate. Attaches holder and gage and repeats check for end play.

Assembles and wires frame: Positions caging motor-gear train assembly and receptacle bracket over pre-machined holes and secures in place with setscrews. Fits wired receptacle into bracket, guides receptacle wires through bracket, and secures receptacle in place with locking ring. Slides solenoid into holding channel of frame and secures in place with setscrews. Inspects blades of 8 and 2 blade switch stacks for straightness and vertical

alignment. Straightens or realigns blades with tweezers when necessary. Attaches switch stacks to frame with setscrews and cleans blades with brush dipped in alcohol. Routes receptacle wires to terminals of switch stacks in accordance with wiring diagram and cuts wires to specified lengths. Prepares wire ends for soldering and solders wires to terminals. Attaches capacitor and resistor to frame and solders lead wires to specifeed terminals. Vacuums frame and soldered connections to remove any dust and insulation cuttings. Places drop of glyptol on all setscrews installed and visually inspects work performed.

Assembles gimbal assembly into frame: Positions syncro housing over pre-machined holes in frame. Draws vertical witness mark on square of masking tape and fastens tape on frame with witness mark aligned with index mark of syncro housing. Removes housing and inserts gimbal assembly into frame. Adjusts assembly to engage frame caging rod with outer gimbal pivot. Slides syncro rotor down over slip ring and onto slip ring pivot. Aligns index mark on rotor with witness mark on masking tape and secures rotor to slip ring pivot with locking nut. Removes gimbal assembly from frame and positions assembly in holding fixture. Tightens locking nut down on rotor with spanner screwdriver while holding rotor stationary with box wrench. Winds specified slip ring lead wires and rotor lead wires around each other to form wire pairs. Encases each pair in insulating tubing, solders pair ends together, and coils joined wires down inside syncro rotor. Positions retainer down on top of locking nut and secures in place with setscrews. Slides slip fit bearings onto outer gimbal pivots and inserts gimbal assemlly into frame with bearing opposite slip ring into frame bearing bore. Rotates assembly to seat bearing in bore. Positions syncro housing over pre-machined holes in frame, secures in place with washers and setscrews, and assembles shim and bearing retainer on housing. Positions and assembles wiper molding on housing, aligns wiper wires with slip ring grooves, and solders wiper lead wires to housing terminals. Encases receptacle wires in tubing to form bundle and lays bundle of wires up along exterior side of frame. Attaches clamping bracket over bundle and fastens bracket to syncro housing. Routes and solders receptacle wires to housing terminals indicated in wiring diagram. Assembles condensor and resistor to frame and solders lead wires to terminals specified. Places drop of glyptol on all setscrews installed and inspects work. Removes gyro assembly from holding fixture and inserts assembly into metal covering can.

IV. Experimental Battery

All the tests of the GATB, B-1002A , were administered to the sample group.

V. Criterion

The criterion consisted of first level supervisory ratings made on an adaption of the Descriptive Rating Scale developed by the United States Employment Service, Form SP-21, with a time interval of two weeks between the first and second ratings. The rating scale consisted of nine items with five alternatives for each item. The alternatives indicated the degree of job proficiency attained. Weights of one through five were assigned to the alternatives so that the minimum possible total score was nine and the maximum forty-five. The coefficient of reliability between the two ratings was .925 indicating a high significant relationship. The final criterion score consisted of the combined score for the two ratings. The distribution of the combined scores ranged from 38-88, with a mean score of 66.24 and a standard deviation of 10.74.

VI Qualitative and Quantitative Analyses

A. Qualitative Analysis

On the basis of the job analysis data, the following aptitudes were rated "important" for success in this occupation:

Form Perception (P) - required to correctly position, align, and assemble small component parts; to perform visual inspection for accuracy in assembly operations; and to detect defects in parts and to make visual discriminations regarding relationships between small intricate parts.

Clerical Perception (Q) - required to perceive pertinent detail in schematic and wiring diagrams; to read tension and dial gages and micrometers; to align index with witness marks; and to select by parts identification numbers, matched pairs of rotor shells, inner and outer gimbals, and gimbal assemblies and frames.

Finger Dexterity (F) - required to pick up, position, and assemble small parts using small hand tools; to position and prepare wire ends for soldering; and to make mechanical wraps to hold wire ends on terminal posts.

Manual Dexterity (M) - required to position, assemble, turn, rotate, and insert parts in assembly and inspection operations; to manipulate soldering iron, arbor press lever, and larger hand tools such as spanner screwdriver and box wrench; and to place or remove assemblies from holding fixture.

B. Quantitative Analysis:

TABLE II

Means (M), Standard Deviations (σ), and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N = 50

Aptitudes	M	σ	r
G-Intelligence	93.6	13.6	.124
V-Verbal Aptitude	95.9	13.7	.007
N-Numerical Aptitude	88.1	15.9	.038
S-Spatial Aptitude	97.0	17.2	.327*
P-Form Perception	96.9	14.9	.166
Q-Clerical Perception	96.8	13.6	.287*
K-Motor Coordination	100.1	17.6	.040
F-Finger Dexterity	107.0	19.1	.316*
M-Manual Dexterity	108.2	18.0	.134

*Significant at the .05 level.

C. Selection of Test Norms:

TABLE III

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X				X	X		X	X
Irrelevant									
Relatively High Mean							X	X	X
Relatively Low Sigma	X	X			X	X			
Significant Correlation with Criterion				X		X		X	
Aptitudes to be Considered for Trial Norms	G			S	P	Q		F	M

Trial norms consisting of various combinations of Aptitudes G, S, P, Q, F & M with appropriate cutting scores were evaluated against the criterion by means of the Phi Coefficient technique. A comparison of the results showed that B-1002 norms consisting of S-80, F-95 and M-85 had the best selective efficiency.

VII. Validity of Norms (Concurrent)

The validity of the norms was determined by computing a Phi Coefficient between the test norms and the criterion and applying the Chi Square test. The criterion was dichotomized by placing 36 percent of the sample in the low criterion group because this percent was considered to be the unsatisfactory or marginal workers.

Table IV shows the relationship between test norms consisting of Aptitudes S, F and M with critical scores of 80, 95 and 85, respectively, and the dichotomized criterion for Instrument Assembler 7-09.610. Workers in the high criterion group have been designated as "good workers" and those in the low criterion group as "poor workers."

TABLE IV

Validity of Test Norms for Instrument Assembler 7-09.610
(S-80, F-95, M-85)

N =	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	8	24	32
Poor Workers	13	5	18
Total	21	29	50

Phi Coefficient = .46
χ^2 = 10.535
P/2 < .005

The data in the above table indicate a significant relationship between the test norms and the criterion for the sample.

VIII. Conclusions

On the basis of the results of this study, Aptitudes S, F and M with minimum scores of 80, 95 and 85, respectively, have been established as B-1002 norms for Instrument Assembler 7-09.610. The equivalent B-1001 norms consist of S-85, F-100 and M-90.

IX. Determination of Occupational Aptitude Pattern

The data for this study met the requirements for incorporating the occupation studied into OAP-27 which is shown in Section II of the Guide to the Use of the General Aptitude Test Battery, January 1962.